

A COMPARISON OF METEOROLOGICAL OBSERVATIONS WITH THE OUTPUT OF A REAL-TIME WEATHER-CHEMISTRY FORECASTING MODEL DURING THE TEXAS AQS 2000 FIELD EXPERIMENT



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Motivation

To investigate through model-observation comparisons the appropriate physics parameterizations that are suitable for operational air-quality forecasts for the Houston metropolitan area.

Numerical Model

The coupled weather-chemistry forecasting model combines a modified version of the fifth-generation Penn State/NCAR Mesoscale Model (MM5) and the chemical mechanism of the Regional Acid Deposition Model Version 2 (details about the coupled model can be found in Grell et al. 2000). The transport of chemical species (grid-scale and sub-grid scale) is treated simultaneously with meteorology. Photolysis, biogenic emissions, and deposition are also calculated "online". The model is run with on multiple 1-way nested meshes of 60 km, 15 km, 5 km, and 1.7 km The 60-km mesh was initialized at 00 Z and 12 Z, respectively, using the Forecast System Laboratory/Rapid Update Cycle (FSL/RUC) analyses. The boundary conditions are provided by NCEP's Eta model forecasts. The chemical fields are initialized with the previous forecast to take into account the accumulation effect. The emission inventory was compiled with databases from EPA and TNRCC (see McKeen et al. 2002 and Grell et al. 2002).

Observations

Model forecasts are compared with aircraft and rawinsonde measurements were taken during the field experiment The Texas Air Quality Study 2000. This experiment was carried out in August and September of 2000 around the Houston area by a team of researchers from federal and Texas state agencies, and universities.

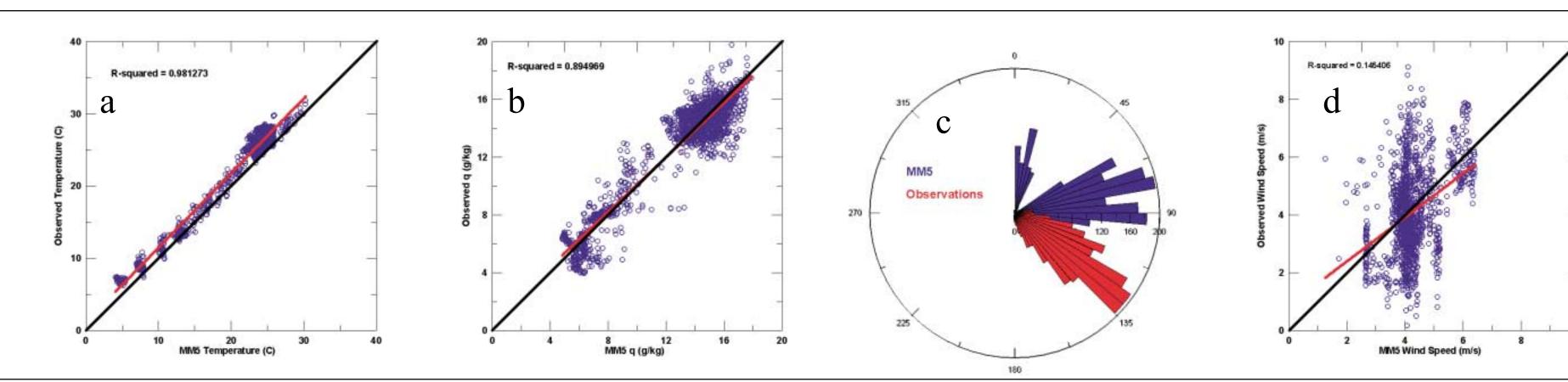
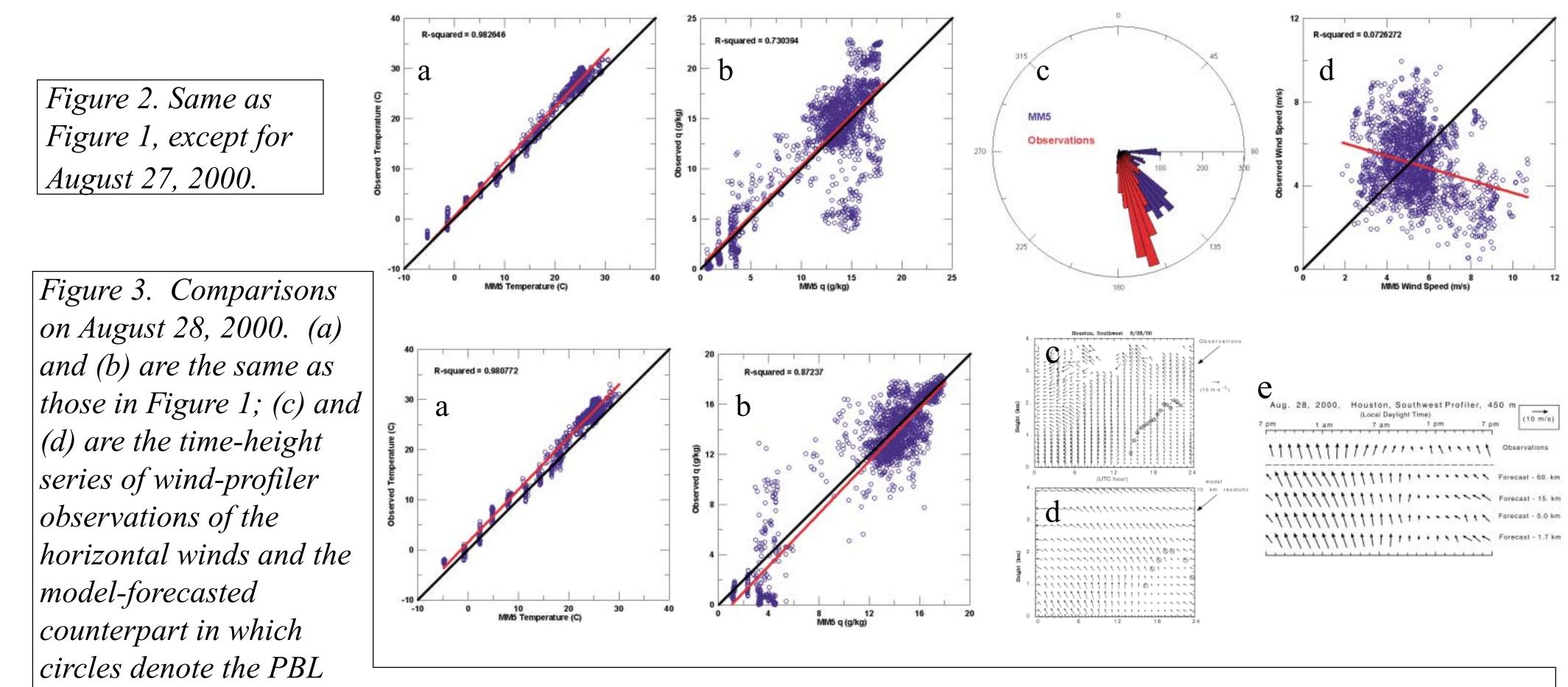


Figure 1. Comparison of model with observations on August 25, 2000 for (a) temperature; (b) q; (c) wind direction; and (d) wind speed. The solid black lines in a, b and d indicates observation = model forecast. The solid red lines in (a), (b), and (d) indicate the best linear fit.



height; and (e) is the comparison of the observed horizontal winds at about 450 m above the surface with the model forecasts with different horizontal resolutions.

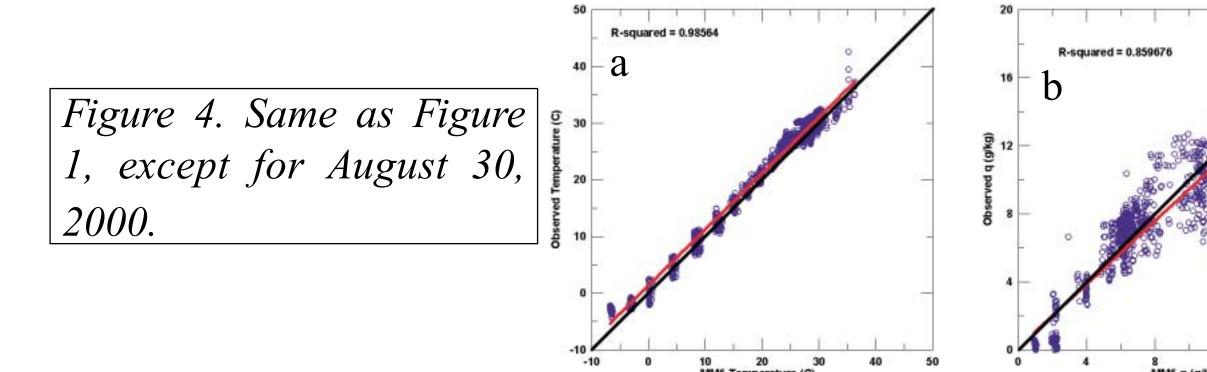


Figure 5. Comparison of model forecasts with aircraft data on August 25, 2000. (a) sounding comparison of water vapor mixing ratio, potential temperature, temperature, and winds; (b) the same as (a) except for a different flight leg; (c) observed temperature and winds along the Electra flight path; (d) same as (c) except for model forecasted temperature and winds; (e) same as (c) except for observed water vapor mixing ratio; and (f) same as (e) except for model forecasted water vapor mixing

Figure 6. Same as Figure 5,

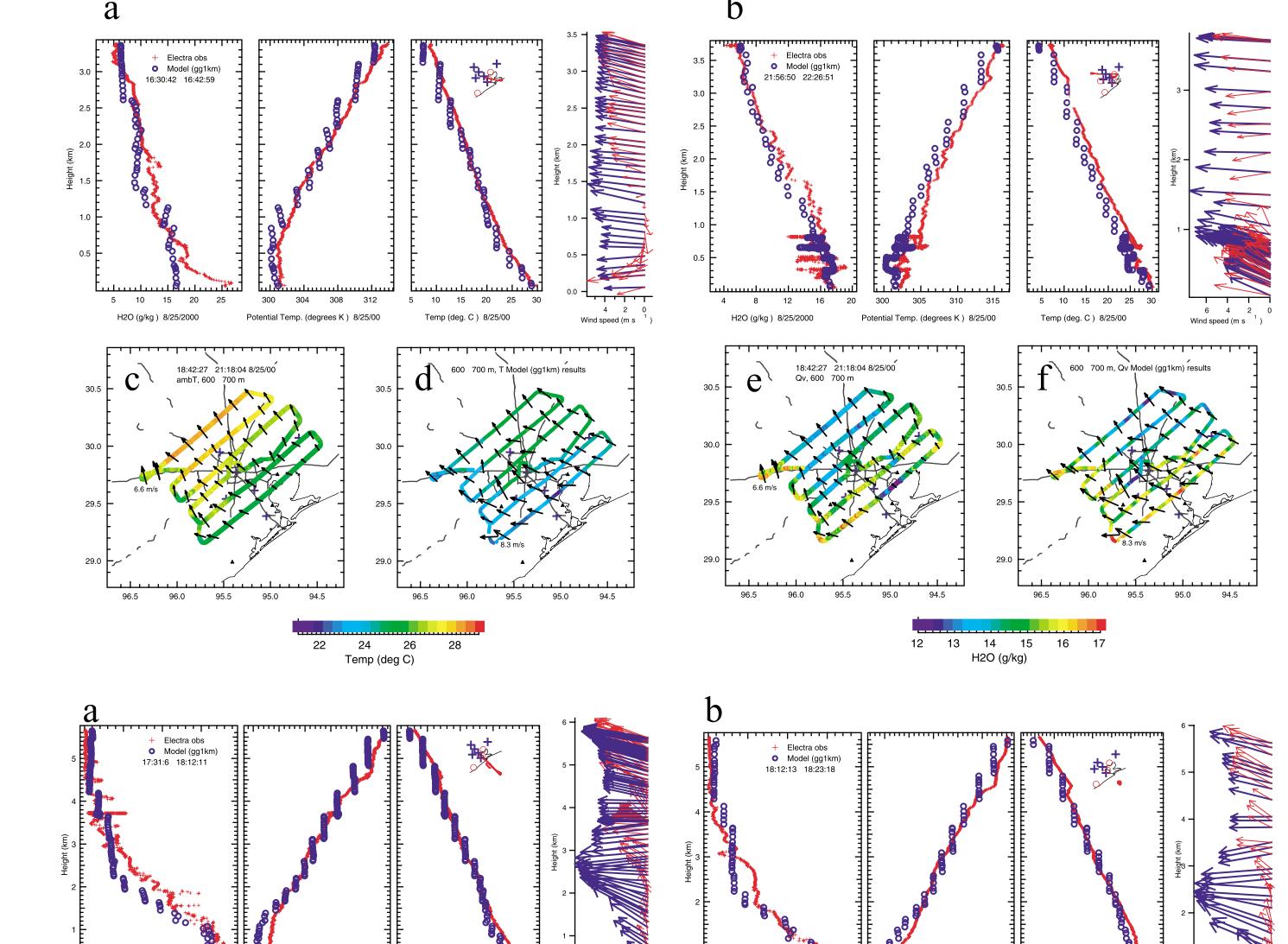
except for August 27, 2000.

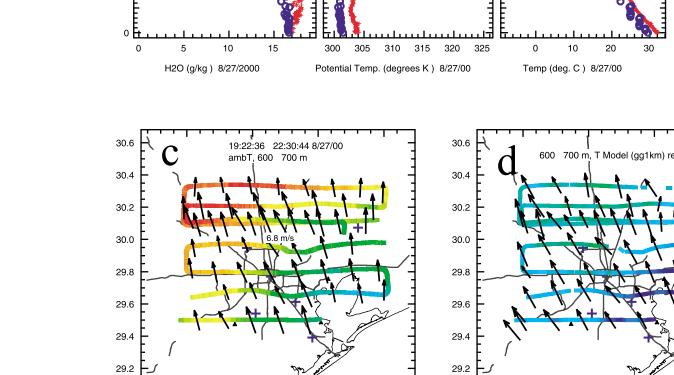
Figure 7. Same as Figure 5,

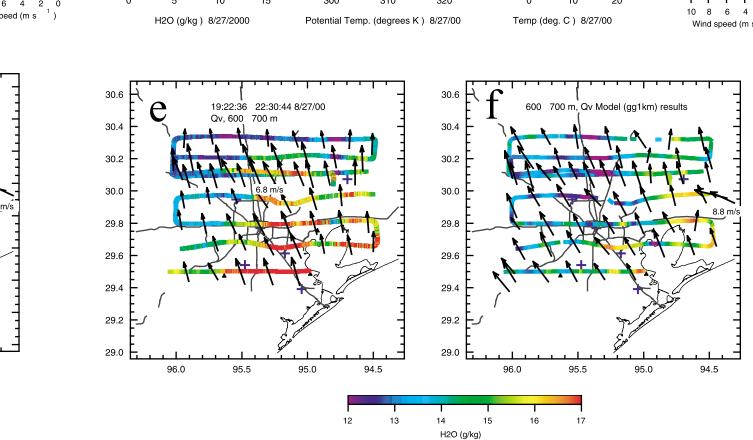
except for August 28, 2000.

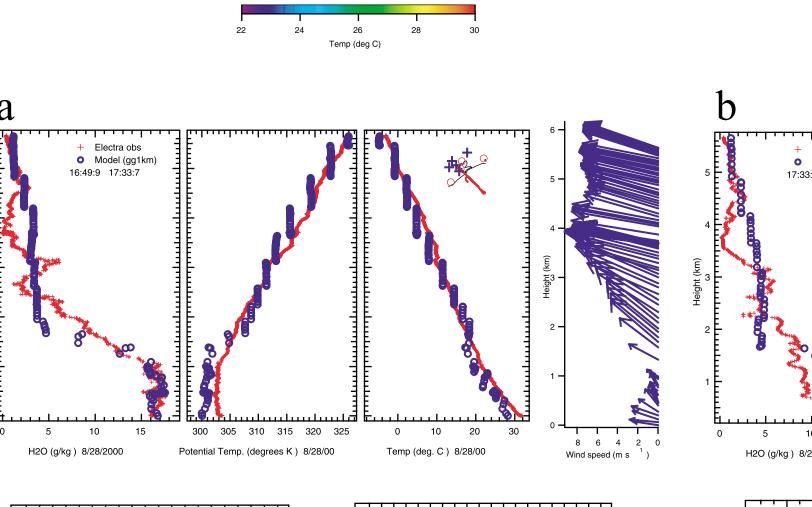
There was no observations

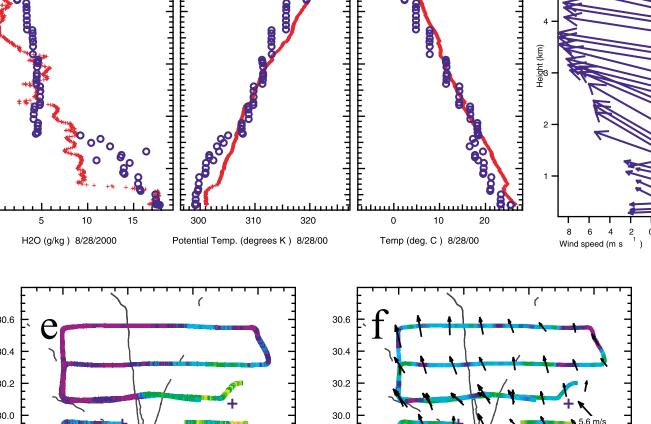
of winds on this day.

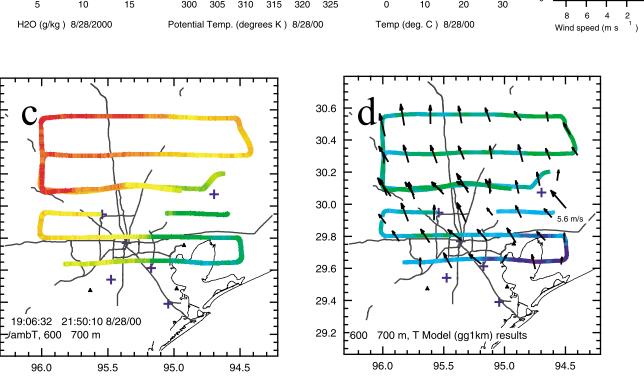












22 24 26 28 30 Temp (deg C)

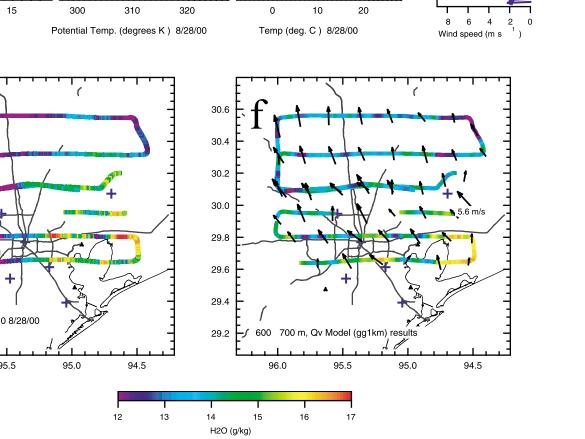
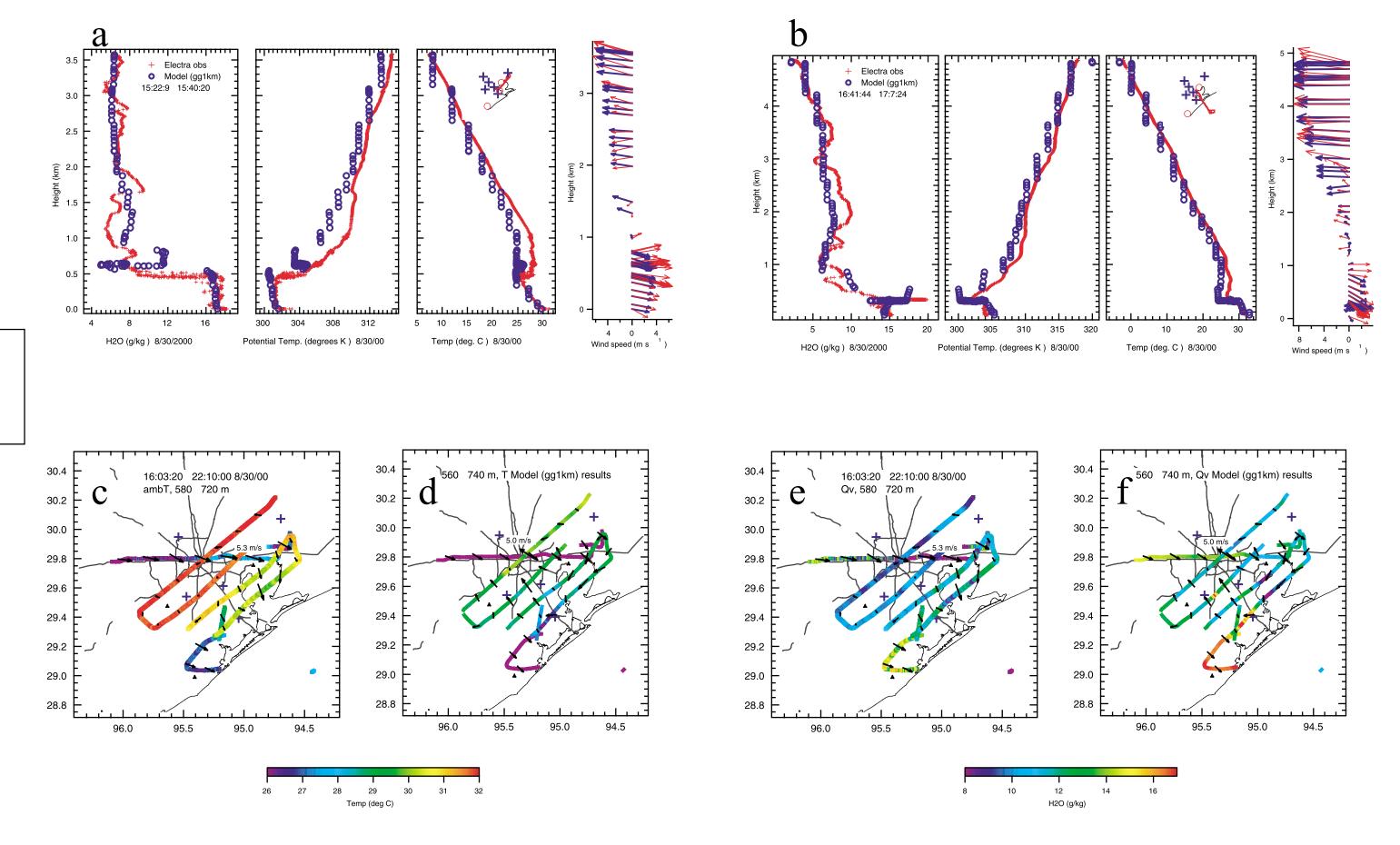


Figure 8. Same as Figure 5, except for August 30, 2000.



Conclusions

From the comparison with wind profile data:

- The forecasted land-sea breeze cycle is in good agreement with the wind-profiler observations, but differences do exist in the wind direction and speed.
- The forecasted nocturnal flow within the lowest 4 km is smoother than that shown by the observations; the low-level winds ahead the sea-breeze front is improved when the model's resolution increases.
- The forecasted PBL mixing layer grows faster comparing with the observations although its on-set and maximum height agree very well with the observations.

From the comparison with Aircraft measurements:

- Model forecasts possess a cold bias at low levels.
- The PBL is colder than that observed when the prevailing low level winds are from the Gulf while it is in better agreement with observations when the low-level winds are from inland.
- A cold bias of the marine boundary layer is suggested.
- The vertical resolution needs to be increased in order to better describe the PBL top entrainment and the PBL evolution.
- The model has a difficulty in handling the influence of small-scale convection.

References

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